Federal Republic of Germany

Patent Application (unexamined)
DE 100 62 545 A1

Int. Cl.[7]
H 04 L 12/26
H 04 L 12/40

File Number: 100 62 545.2
Application Date: 15 December 2000
Laid Open: 20 June 2002

German Patent and Trademark Office

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The following specifications are taken from the documents submitted by the applicant

Method for checking a network and network therefor

A method for checking a network comprised of network nodes and of devices connected to network nodes, includes the steps:
- acquiring the network topology with at least

the network topology with at least the network node number, the network node identity and the wiring of the network inputs and outputs;
- comparing a current network topology with a permanently stored reference network topology for the network for detecting a change of the number and/or type of the devices connected to the network, the network topology and/or the network nodes, at which a change has occurred.

Specification

[0001] The invention relates to a method for checking a network comprised of network nodes and of devices connected to network nodes, wherein the network topology with at least the network node number, the network node identity and the wiring of the network inputs and outputs is acquired.

[0002] The invention relates further to a network with network nodes, which are interconnected in a network topology, and with devices on the network nodes, wherein each of the network nodes [has] stores for storing data for the identification of at least the network node identity and wherein the network for acquiring the current network topology with at least the network node number, the network node identity and the wiring of the network node inputs and outputs is developed by reading out the stores of the network nodes and evaluating the course of the data transmission during the read-out.

[0003] In IEEE Standard 1394 a network with network nodes is described, which offers a serial bus connection between different devices with a high data transmission rate. Such a network is also known by the name FireWire or iLink. The network is substantially formed of network nodes, which have one or several network node outputs. The network nodes can be contained in devices, such as for example radios, monitors, CD players, etc. To the network node inputs and outputs further network nodes can be connected.

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[0004] The higher-ranking node of a network is referred to as the root. In principle, each node can become the root. Two nodes are related in the topology through a child and parent relationship, i.e. the higher-ranking node is referred to as the parent and the lower-ranking as the child. Therefore a node can simultaneously be parent of one node and child of another node.

[0005] Network nodes, which are only connected to one further network node, are referred to as terminal nodes (leaf). Network nodes with two or more connected network nodes are referred to as branch.

[0006] The network, on which the invention is based, is developed such that it becomes configured independently without a host processor, wherein the detection of the network topology, i.e. the configuration of the network, is carried out after a reset of the network. A reset of the network is initiated, if, for example, a device or network node is removed from the network or a further device or network node is added to the network. The configuration of a network conventionally takes place in three stages:

1. Bus initialization

[0007] The bus initialization is triggered via a reset command, and the individual network nodes conduct the reset signal further to the other network nodes. In the network nodes all information regarding the previous network topology is deleted and the network nodes brought into the initialization state.

2. Branch Identification

[0008] In the branch identification the topology of the network is detected and the dependence of the network nodes with respect to one another is identified. Through the independent identification of the network nodes as "parent" and "child", a network root node is designated as

an output node, which assumes the bus or network management.

3. Self-Identification

[0009] The network topology and the physical properties of the network nodes must be known for the network management. For this purpose the network nodes transmit during the self-identification the most important physical properties in a self-ID packet. The transmission of the data of the individual network nodes takes place in the sequence of the topology configuration of the network, such that the position of the network nodes in the network can be identified. The network root nodes store within the "topology map" the number of connected network nodes and their self-ID packets. The network topology, the network node number "phy_id" and the physical properties of the connected network nodes can be queried based on the topology map.

[0010] For the network configuration a register store is provided in each network node, in which a network node or device identification number as well as further information about the network node or the device are stored. Each device or each network node is provided with a unique identification of the manufacturer "vendor ID", which is also stored in the register store. In addition, a unique number of the integrated switching circuits is stored in the register store (chip ID), in which the hardware and software is installed for realizing the network node. As supplemental information the physical properties of the network node and the states of the associated network outputs (ports) can be entered in the register store. The properties can be, for example speed (sp = speed), delay time (del = delay), gap distance (gap-cnt = gap count), voltage class (pwr = power class), etc.

[0011] As a rule, the network root node has available a register store for storing the so-called network topology map, which [stores] the number of connected network nodes and the information, sent from the network nodes to the network root nodes, about the properties of the particular network nodes (self-ID packets). To each network node a network node number

"phy_id" is assigned herein by the network root node. The information (self-ID packet) sent from a network node to the network root node includes the network node number (phy_id"), gap number (gap-cnt), speed (sp), delay (del), power class (pwr) as well as additional information.

[0012] In this manner, data transmission from one network node to another network node can take place.

[0013] The IEEE Standard 1394 defines a serial bus. Similar buses are also MOST, HiQoS, CAN, universal serial bus (USB), etc., which also represent a network according to the species.

[0014] In conventional networks after a change of the network topology, for example by adding or removing devices, a reset of the network is carried out and the information about the preceding network topology is lost. This is problematic in particular if external devices are added or the network is manipulated.

[0015] The task of the invention therefore becomes specifying a method for checking a network according to the species, in which changes on the network and on the connected devices and network nodes can be identified.

[0016] The task is solved through the method according to the invention by comparing a current network topology with a stored reference network topology for the network for detecting a change of the number and/or type of the devices of the network topology connected to the network and/or of the network nodes, at which a change has occurred.

[0017] It is consequently proposed to store permanently a reference network topology, which, with a reset of the network, is not changed or erased. In this manner the current network topology can be compared with the reference network topology and changes at the network can be detected.

[0018] Upon request, a reference network topology is advantageously stored by transferring a current network topology as the reference network topology, in which the data for the current network topology from a central network topology store for the network and from decentral network node stores are read in and the read-in data are stored in a reference network topology

store.

[0019] Checking the network is carried out independently with a new initialization of the network.

[0020] Comparing the current network topology with the reference network topology preferably takes place by comparing the data contents, which are stored in a comparison network topology store and a reference network topology store. The data for the current network topology are herein read in from a central network topology store for the network and from decentral network node stores and stored in a comparison network topology store.

[0021] It is especially advantageous if the reference network topology is restored again by automatic deactivation of network nodes, network node outputs and/or devices at the network node outputs, which are not provided in the reference network topology. In this way not only monitoring of the network, but also securing against manipulation of the network and misuse through unauthorized external devices is excluded.

[0022] The method is preferably applied to a network corresponding to IEEE Standard 1394, but can equally well also be used for Universal Serial Buses (USB networks) or Most networks, etc.

[0023] Corresponding to the above described invention, in the network according to the species a store is provided for the permanent storage of a reference network topology for the network and a comparison unit for comparing the current network topology with the reference network topology for checking the network and detecting a change of the number and/or type of the devices connected to the network, the network topology and/or the network nodes, at which a change has occurred.

[0024] The network is preferably developed for automatic storage upon request of the acquired current network topology as the reference network topology in the store for the reference network topology. In this way a current network topology, recognized as a permitted one, is defined as the reference network topology for future checks.

[0025] The network is furthermore preferably developed for the independent checking of the

network after a new initialization or an addition or removal of a network component.

[0026] It is furthermore advantageous if a comparison network topology store for storing the acquired current network topology in the network, is provided especially in a network root node. The comparison unit is then developed for comparing the data contents, which are stored in the comparison network topology store and in the reference network topology store.

[0027] The network, and especially the network nodes, are especially advantageously developed such that they restore the reference network topology through automatic deactivation of network nodes, network node outputs and/or devices at the network node outputs, which are not provided in the reference network topology.

[0028] The network corresponds preferably to IEEE Standard 1394 or corresponding other standards, such as for example the Universal Serial Bus standard (USB, MOST, HiQoS, CAN, etc.).

[0029] The invention will be described by example in further detail in the following in conjunction with enclosed drawings of a network according to the IEEE Standard 1394. In the drawing depict:

[0030] **Fig. 1** schematic representation of a simple network with six network nodes;

[0031] **Fig. 2** schematic representation of the changed network from Fig. 1;

[0032] **Fig. 3** drawing of the method for reading a current network topology into the comparison network topology store;

[0033] **Fig. 4** drawing of the method for initializing the reference network topology and for checking the current network topology;

[0034] **Fig. 5** table showing the store content of the network topology map according to the Standard 1394;

[0035] **Fig. 6** table showing the data packet "Self-ID packet" according to Standard 1394 sent by the network nodes;

[0036] **Fig. 7** minimum register store content for the network properties of a network node according to Standard 1394;

[0037] Fig. 8 general store content of the register store of a network node according to standard 1394.

[0038] Fig. 1 shows the schematic representation of a network, which is comprised of six network nodes Node A to E. The starting point of the network is formed by the network node Node A, which is denoted as network root node and as such assumes the network management. To this network node Node A is assigned the identity number phy_id = 4. It has three network node outputs A, B and C. To the network node output A is connected a further network node Node B with the identity number phy_id = 1 to port C and the network node Node A is designated as "parent" and the subjacent network node Node B as "child".

[0039] To the network node terminal A and B additional network nodes Node C and Node D with the identification numbers phy_id = 0 and phy_id = 2 are connected. These network nodes Node C and Node D form the termination of the network and are consequently denoted as termination nodes (leaf). They form, in turn, the child node with respect to the network node Node B, which is a parent node.

[0040] To the network terminal B of the network root node Node A a further terminal node Node E is connected with the identification number phy_id = 3.

[0041] The network topology is determined by the assignment of the network nodes to one another as "parent" and "child", as well as through the physical properties of the network nodes and the devices connected to the network nodes. The network is suitable especially for digital audio and video applications, for example for CD players, video recorders, camcorders, monitors, etc. The network root node in the depicted example forms a transmission interface for a device according to the digital audio broadcast standard DAB.

[0042] Fig. 2 shows by example a change of the network from Fig. 7 [*sic*: 1] with the network nodes Node D and Node E being exchanged. The identity number phy_id remains dependent on the position of the network node in the network, such that the network node Node E receives the identification number phy_id = 2 of network node Node D, which previously had

been at this position. The same applies to the network node Node D, which receives the identification number phy_id = 3.

[0043] The network or the individual network nodes are developed such that they can automatically recognize the network topology. The network topology is herein stored in a so-called topology map in the root node.

[0044] Acquiring the network topology is outlined in Fig. 3. It is evident that each network node has a register store ROM, in which at least the network node identity and the wiring of the network node outputs is stored. In each network node a unique manufacturer number Vendor ID as well as further information regarding the physical properties of the network node is fixedly written. Reference to the content will again be made in detail in conjunction with Fig. 5 to 8.

[0045] According to IEEE Standard 1394, the current network topology is automatically acquired as soon as a network node or device is removed or added.

[0046] After the removal or addition of the node, a reset is triggered. The assignments are newly given out, i.e. a different node can become the root. The transmission of the information proceeds partially independently without continuous renewal of the demand by the root node.

[0047] Subsequently information from the lower-ranking network nodes Node 0 to Node N-2 are supplied to the network root node and the network node number in the network, the identification numbers phy_id, information about the communication and physical properties of the network nodes, etc. are stored in the so-called topology map. The detailed content of the topology map will be explained later in conjunction with Fig. 5.

[0048] Based on the topology map the communication in the network is controlled by the network root node.

[0049] According to the invention now a current comparison network topology is deposited in the so-called ID map store, in that the data contents are read out from the topology map and the network node register stores ROM and deposited in a defined manner in the ID map store.

[0050] In Fig. 4 is evident that with an initial initialization of the network upon request a

reference network topology on the basis of a current network topology, which is to serve as the reference network topology, is stored. For this purpose, as already outlined in Fig. 3, the topology map and the register store ROM of the network nodes Node 0 to Node N-1 are read in.

[0051] Upon request or with a reset of the network the network is automatically checked in that the current network topology is compared with the reference network topology. A reset is automatically carried out according to IEEE Standard 1394, for example as soon as a network node or terminal device is added to the network or removed from it. A reset can also be triggered for different reasons, such as for example with a change of the power mode from standby mode to on mode.

[0052] Checking the network takes place such that the comparison network topology is acquired by reading in the data content of the topology map and of the register store ROM of the network nodes and comparing them with the permanently stored reference network topology (reference ID map).

[0053] The changes of the network can be displayed on a monitor, for example logged via a printer, or also corrected. The restoration of the reference network topology can take place such that the network nodes or devices added without authorization can automatically be deactivated.

[0054] Fig. 5 shows the data content of the topology map according to the IEEE Standard 1394. The topology map consists initially of basic information, such as for example length, as well as of basic information about the network, such as node number (node count) and number of the data packets (self ID count) sent by the network nodes. Further, the data packets sent by the network nodes are stored successively.

[0055] From the network nodes the data packets outlined in Fig. 6 are sent to the network root node. The data packets (self ID packets) consist essentially of the identification number phy_id of the network node, the gap count, the speed (sp), the delay (del), the power class (pwr) and information about the network node terminals P0, P1 and P2. The phy_id is automatically assigned through the reset process and is not a physical property of the network node stored in

the store of the network node. The identification number phy_id is uniquely determined by the sequence in the transmission of the self ID packets according to the sequence child/parent.

[0056] The network topology can be uniquely determined based on the data packets in conjunction with the identification number phy_id, the network node terminals P0, P1 and P2 as well as the network node number "node count". The additional information is not necessarily required for checking the network, but can be helpful in order to detect possible manipulation on the network nodes or end devices.

[0057] Accordingly, when reading out the register store ROM of the network nodes as well as when reading out the topology map to establish the comparison network topology or the reference network topology, it is not necessary to read out and compare all data contents, but only the required data contents.

[0058] Fig. 7 shows the minimum data content of the register store of a network node, which consists of the header 01H and the unique manufacturer identification vendor ID. Furthermore, the additional information outlined in Fig. 8, can be deposited in the register store of the network nodes. However, the content of these data is not of significance in the following, so that reference is made to IEEE Standard 1394.

[0059] What is of importance for the network according to the species is that the network nodes are developed such that they automatically generate the data packets (self ID packets) and sent them to the network root node, such that in the topology map the physical properties of the network nodes and the states of the associated network node terminals can be entered.

[0060] The corresponding network management procedures are conventionally implemented in an appropriately specialized integrated switching circuit (chip). Checking the network and the network management is consequently not carried out by a host computer but by the appropriately specialized integrated switching circuit or in software.

Patent Claims

1. Method for checking a network comprised of network nodes and of devices connected to the network nodes, with the steps:

   - acquiring the network topology with at least the network topology with at least the network node number, the network node identity and the wiring of the network inputs and outputs

   characterized by

   - comparing a current network topology with a permanently stored reference network topology for the network to detect a change of the number and/or type of the devices connected to the network, the network topology and/or the network nodes, at which a change has occurred.

2. Method as claimed in claim 1, in which a current network topology is stored as the reference network topology by
reading the data for the current network topology from a central network topology store for the network and the decentralized network node stores, and storing the read-in data in a reference network topology store.

3. Method as claimed in claim 1, characterized in that the checking is automatically carried out with a new initialization of the network.

4. Method as claimed in one of claims 1 to 3, characterized by
reading the data for the current network topology from a central network topology store for the network and decentral network node stores,

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storing the read-in data into a comparison network topology store,
comparing the current network topology with the reference network topology by comparing the data contents, which are stored in the comparison network topology store and in a reference network topology store.

5. Method as claimed in one of the preceding claims, characterized by the restoration of the reference network topology through the automatic deactivation of network nodes, network node outputs and/or devices at the network node outputs, which are not provided in the reference network topology.

6. Method as claimed in one of the preceding claims, in which a network corresponding to the IEEE Standard 1394 is checked.

7. Network with network nodes, which are interconnected in a network topology, and with devices on network nodes, in which each of the network nodes include stores for storing data for characterizing at least the network node identity and the wiring of the network node outputs, and in which the network for acquiring the current network topology with at least the network node number, the network node identity and the wiring of the network node outputs is developed by reading-out the stores of the network nodes, characterized by
a store for storing a reference network topology for the network and
a comparison unit for comparing the current network topology with the stored reference network topology for checking the network and detecting a change of the number and/or type of the devices connected to the network, the network topology and/or of the network nodes at which a change has occurred.

8. Network as claimed in claim 7, characterized in that the network is developed upon

request for automatic storage of the acquired current network topology as the reference network topology in the store for the reference network topology.

9. Network as claimed in claim 7 or 8, characterized in that the network is developed for the automatic checking of the network after a new initialization or an addition or removal of a network component.

10. Network as claimed in one of claims 7 to 9, characterized by a comparison network topology store for storing the acquired current network topology, wherein the comparison unit is developed for comparing the data contents, which are stored in the comparison network topology store and in the reference network topology store.

11. Network as claimed in one of claims 7 to 10, characterized in that the network is developed for the restoration of the reference network topology by automatically deactivating network nodes, network node outputs and/or devices at the network node outputs, which are not provided in the reference network topology.

12. Network as claimed in one of claims 7 to 11, characterized in that the network corresponds to IEEE Standard 1394.

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3 sheets of drawings enclosed

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Fig. 3

Read

ID Map
Store

Fig. 4

Initialization

Reference

Topology Check

Reference
ID Map

Comparison

Topology Map

Comparison
ID Map

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